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RESEARCH RESULTS DIGEST

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Subject Areas: IIA Highway and Facilities Design and IVB Safety and Human Performance

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Development of a Highway Safety Manual

This digest presents the results of NCHRP Project 17-18(04), "Development of a Highway Safety Manual." This study developed an annotated outline, prototype chapter, and work plan for the first edition of the Highway Safety Manual. This digest is based on a draft final report authored by the principal investigator, Warren Hughes, Bellomo-McGee, Inc.; Kim Eccles, Bellomo-McGee, Inc.; Douglas Harwood and Ingrid Potts, Midwest Research Institute; and Ezra Hauer, University of Toronto.

SUMMARY

This digest summarizes the final report for NCHRP Project 17-18(04) (available as *NCHRP Web Document 62*). This is the initial project in a ground-breaking effort to develop a Highway Safety Manual (HSM). The HSM will serve as a tool to aid practitioners in making planning, design, and operations decisions based on safety considerations. Project 17-18(04) developed an annotated outline for the first edition of the HSM, a work plan for producing the first edition by 2007, and a prototype chapter for safety estimation on two-lane rural roads.

INTRODUCTION

There has been a growing recognition that transportation professionals do not have the tools needed to consider safety explicitly when making decisions related to the planning, design, construction, operation, and maintenance of transportation facilities, notably highways. Many involved in highway safety research have expressed the belief that transportation professionals may not have made sound decisions because they lack the information of the explicit effects on safety. The perception shared by many in the area of highway design has been that an acceptable level of safety is achieved if minimum geometric design standards are met. Unfortunately, crash statistics and forensic investigations have shown that high crash rates, frequencies, and severities can occur at locations where geometric conditions meet or even exceed minimum geometric design standards.

In addition, some transportation professionals have not been able to convince decision-makers within their transportation or highway agencies of the need for additional changes in highway projects to enhance safety. The reason is that there has been no definitive source of information about the expected safety effects resulting from these changes. Transportation professionals have been left to their own resources to develop and present the argument for safety improvements to decision makers. Frequently, these arguments have been rejected because they have been perceived as subjective in nature and not well founded. Although safety may be one of many factors considered in making decisions about highways, safety findings have been often misused to support wildly divergent claims in support of specific decisions.

There is a significant opportunity for improving the explicit role of highway safety in making decisions on roadway design and operations. Improved, low-cost technologies have encouraged many state DOTs and other agencies to develop systems to deliver better safety information. In addition, there has been a parallel advancement in the science of safety impact prediction. Better understanding of the statistical nature of crashes, coupled with new analytical tools, makes it possible to produce more valid estimates of the effect of geometric and operational changes on the frequency and severity of crashes.

AASHTO has developed a strategic highway safety plan that includes 22 emphasis areas containing a number of countermeasures designed to quickly reduce fatalities on our nation's roads. Two of the initiatives address safety information

and management of the highway safety system. A key strategy for these initiatives involves improving safety information systems for better decision support.

Furthermore, the move toward "context sensitive design" approaches has put additional pressure on state and local agencies to develop the means and tools for making design decisions that may involve exceptions to existing criteria. The safety impacts of such decisions should be explicitly considered.

Recent legislative requirements for improving safety data and the use of safety as an explicit criterion in planning and designing transport facilities have created needs within many agencies for improved tools and techniques for safety analysis. Although there have been substantial investments in research and development on highway safety related to the roadway environment [e.g., FHWA's program to develop the Interactive Highway Safety Design Model], there is no commonly accepted, fully integrated approach for safety analysis of designs. Hence, safety may not be incorporated in the most effective manner.

BACKGROUND AND RESEARCH OBJECTIVES

Several years ago, the need for including highway safety to some degree within the Highway Capacity Manual was raised and discussed within TRB's Highway Capacity Committee. Concurrently, efforts were initiated within TRB's Safety Data, Analysis and Evaluation Committee to investigate the possibility and potential of a separate, stand-alone manual that would address highway safety in a manner similar to how highway capacity is addressed within the Highway Capacity Manual. First, an ad hoc task force was established, which grew into a Highway Safety Manual subcommittee within the Safety Data, Analysis and Evaluation Committee. Over approximately 6 years, several presentations were made at TRB Annual Meetings and the interest grew. Other TRB committees involved with highway safety were quick to recognize the need and co-sponsored the activities of the subcommittee, which became the Highway Safety Manual Joint Subcommittee (HSM JSC).

In December 1999, a workshop was held, under sponsorship of eight TRB committees funded by FHWA to determine the need for, nature of, and feasibility of producing a Highway Safety Manual (HSM). About 25 researchers and practitioners participated in the workshop and concluded that there was definitely a need for such a technology transfer activity and that work should begin as soon as possible on the development of an HSM.

It was recommended that the HSM have similar attributes to the *Highway Capacity Manual*. The purpose of the HSM will be to provide the best factual information and tools, in a useful and widely accepted form, to facilitate roadway planning, design, and operational decisions based on explicit consideration of their safety consequences.

NCHRP Project 17-18 and FHWA jointly funded this initial project to develop a Highway Safety Manual. The objectives of this project were to (1) complete a scoping study that details the effort required to produce the first edition of the HSM, (2) develop an annotated outline for the HSM, and (3) develop a prototype chapter that incorporates the analytical procedure being developed by the FHWA for safety estimation on rural two-lane highways.

RESEARCH APPROACH

The research approach for each of the three main products of this research, the annotated outline, work plan, and prototype chapter, is described in the following sections.

Annotated Outline

Working closely with the JSC, especially the Content Task Group, the research team developed the structure of the annotated outline through an iterative process. The basic structure of the outline was developed by the JSC at the 2001 TRB Annual Meeting. The basic structure includes five parts: Part I—Introduction and Fundamentals, Part II—Knowledge, Part III—Predictive Methods, Part IV—Safety Management of a Roadway System, and Part V—Safety Evaluation.

Together with the Content Task Group, the research team used their knowledge of the state of the practice in many of the subject areas to provide detail to this basic structure. Topics were included in this detailed outline based on the availability of knowledge and the usefulness of the material for the intended audience. This expanded outline was presented to the JSC at the 2002 TRB Annual Meeting for review. It was also submitted to the NCHRP project panel for review.

A detailed literature search was undertaken to identify materials to be annotated to the outline for each of the topic areas identified. Primarily, the following sources were used to identify this literature:

- U.S. Department of Transportation, Bureau of Transportation Statistics and National Transportation Library, and TRB Transportation Research Information Service (TRIS) bibliographic database Version 2.0.
- The TRB Research in Progress Website.
- The Pedestrian and Bicycle Information Center websites.
- FHWA Guidelines for Signalized Intersections, Task A—Critical Review of Literature and Comparison of Risk Levels Associated with Different Treatments at Signalized Intersections, Draft Report, March 2002. [Unpublished document]
- Road Safety Research website, Dr. Ezra Hauer, on-line at http://www.roadsafetyresearch.org
- Citations from the Ministry of Transportation of British Columbia library electronic catalogue. Provided by Melanie Perkins, Transportation Engineering Specialist,

Engineering Branch of the Ministry of Transportation of British Columbia.
- Bibliography of the Interim Highway Safety Programs Manual, British Columbia, 1999. Provided by Melanie Perkins, Transportation Engineering Specialist, Engineering Branch of the Ministry of Transportation of British Columbia.

The research team conducted a limited review of the abstract of each potential item. Items were included in the annotated outline on the basis of their relevancy to the subject matter, study design, and timeliness. The research team concentrated on identifying literature that provided quantifiable safety effects, especially for materials for Part II.

The annotated and revised outline was presented to the JSC for review at the 2002 midyear meeting. The JSC identified revisions and then approved the annotated outline based on those revisions. The annotated outline, included as Appendix B of the final report, represents the JSC-approved annotated outline.

An abbreviated outline is included as Appendix A of this digest.

Work Plan

The work plan was developed in close coordination between the research team and the Policy Task Group. The research team was also in close communication with the agencies, namely FHWA and NCHRP, which will fund most of the research that will form the basis of the first edition of the HSM.

The structure of the work plan was modeled after the work plan used by the Highway Capacity Committee to develop the Highway Capacity Manual. One of the main elements of the work plan is the action plan. The action plan identifies and briefly describes the tasks and subtasks necessary to create the first edition. The action plan specifies three types of tasks, categorized by their overall function: preparation tasks, development tasks, and composition and production.

Vital to the schedule for the work plan was the progression of the action plan, given that the action plan often controls the time scheme for completion. The intention of the JSC at the TRB Annual Meeting in 2002 was to produce a first edition of the HSM in 5 years. Based on a realistic assessment of the likely funding cycle and progression of the research, the delivery date for the first edition of the HSM was changed to December 2007. The schedule was developed accordingly.

Prototype Chapter

Similar to the annotated outline, the prototype chapter was developed in coordination with the Content Task Group. First, the research team identified critical elements for the prototype chapter. After these elements were developed, a draft outline was produced. The resulting prototype chapter was drawn heavily from the rural two-lane accident prediction model developed for the Interactive Highway Safety Design Model. This model was used because it represents the best state of the practice in accident prediction. The research team was in periodic contact with FHWA to discuss the progress of the model and worked to develop the prototype chapter in this context.

The prototype chapter was intended to illustrate the content and format of chapters that will be included in Part III of the first edition HSM.

FINDINGS

The findings of this study are documented as three products. These products constitute the appendices to the draft final report as follows:

- Appendix A—Annotated Outline for a First Edition of the Highway Safety Manual
- Appendix B—Work Plan for the Development of a First Edition of the Highway Safety Manual
- Appendix C—Prototype Chapter on Two-Lane Rural Highways

The annotated outline includes the five parts that will constitute the HSM. Part I introduces the materials and provides information on the fundamental safety relationships. Part II of the HSM will be the knowledge sections. Topics that will be included in this section are outlined with annotations of relevant literature. Part III of the HSM will constitute the predictive methods chapters. Part IV will provide information on the safety management of a roadway system. Part V will provide information on conducting safety evaluations.

The work plan for the first edition of the HSM consists of four elements: an action plan, a level-of-effort estimate for each of the proposed chapters, a schedule of activities, and an identification of research needs.

The prototype chapter is a prototype of Chapter 8: Rural, Two-Lane Roads. This chapter is intended to be in Part III of the HSM. The prototype chapter is intended to illustrate both the content and format of chapters in Part III.

The three products of this research are intended to aid in the development of the first edition of the HSM. Because the first edition HSM is a developing project, the products of this research are evolving. For instance, as the state of the research advances, topics may need to be added to the annotated outline to ensure that they are addressed in the HSM. Alternatively, for topics already identified in the annotated outline, references to new literature may be added as the research results become available. Additionally, the work plan must be able to accommodate potential changes in the timeline, funding, or staffing levels needed. The duration of tasks, costs, and level of effort were all estimated on the

basis of the best available information; however, these estimates probably will change as the project progresses and more is understood about the needs of each task.

Issues

Many issues will need to be addressed in the preparation of the draft first edition of the HSM and in the development of subsequent editions. These issues are identified and discussed briefly in the following paragraphs. Many of these have been considered and, to a certain degree, addressed during the preparation of the three major products of this research (i.e., the annotated outline, work plan and prototype chapter). However, the development of the HSM is evolving and the vision is still very much being shaped and modified. Thus, these issues will continue to present challenges in the years ahead.

Funding

In order to produce the first edition of the HSM, funding is required for the following:

- Conduct of research to develop the procedures and tools for the HSM,
- Composition of other sections and chapters, and
- Production of draft review and final release versions.

The level of effort required to develop the HSM are beyond the limits of what can be reasonably expected from members of a TRB committee, task force, or joint subcommittee to provide on a voluntary basis. For the HSM to be useful, additional funding sources need to be identified and funds need to be obligated to this effort. NCHRP approved funding to develop crash prediction models for urban and suburban arterials and multilane rural highways. These are two of the three major highway types for which accident prediction methodologies are to be included in the first edition. The first highway type is two-lane rural roads. FHWA is funding ongoing research to develop and refine crash prediction models for two-lane rural roads. Although this level of funding for the initial research efforts may be adequate to continue efforts toward the development of the tools for the first edition, long-term sources of funding are needed to sustain and improve on the first edition. Specifically, the goal is to produce crash prediction methodologies for other highway facility types, including urban divided and undivided streets, urban two-lane streets, urban freeways and expressways, and ultimately rural interstate freeways. Consequently, research will be needed to develop the initial predictive tools similar to those being developed for two-lane rural highways, multilane rural highways, and urban and suburban arterial highways. Predictive tools require dedicated funding. Moreover, after the tools in the first edition of the HSM have been released and users have had the opportunity to apply these tools, then deficiencies and limitations with the procedures will most certainly be identified. Revisions will then necessitate enhancements and improvements to the methodologies, which in turn are likely to spur the need for more research. Hence, continued funding will also be needed to upgrade the predictive methodologies for two-lane rural and multilane highways and urban and suburban arterial highways.

Involvement of Multiple Perspectives

Based on several meetings, there is a clear need to embrace multiple perspectives during the preparation of this first edition and subsequent editions. Many safety practitioners have asked that the document be sufficiently broad in coverage of topics considered under the highway safety umbrella. The consensus has been that this document should not be written solely for a small group of potential users (e.g., just highway designers or traffic engineers). Writing for a broad audience creates challenges. As the breadth of materials covered by the HSM increases, the scope and size of the document also increase. Thus, it becomes more difficult to produce a meaningful document if it means that the document must be all things to all people involved in highway safety. There are limits as to what realistically can be produced. This is especially true if the concern is to present meaningful information that is well founded and based on empirical studies. The decision made for this project was to sharpen the focus of the first edition of the HSM. Specifically, the objective was to provide the best available information to assist transportation professionals involved in the planning, design, and operations of highways so they could make more informed decisions that explicitly consider safety. Other constituencies in the highway safety community will expand the HSM to cover topics outside the subject matter covered by the first edition. This will be a continual challenge to those involved in the stewardship of the HSM.

Another example related to multiple perspectives are the significant differences of opinions within the core group of transportation professionals who have become the primary caretakers of the HSM. Even the very name of the manual has been hotly debated. At the California conference in 1999, specifically the title of the document was openly discussed and many favored the title, Roadway Safety Manual, rather than Highway Safety Manual, because of the numerous connotations associated with the term highway safety. Many in the traffic enforcement community, driver licensing community, and driver behavior programs are likely to expect that relevant topics related to the driver, vehicle and enforcement will be adequately covered in an HSM. The decision was made that the title should be Highway Safety Manual and the focus of the manual is not on those topics, albeit they are likely to be mentioned briefly in the first edition. Involving multiple perspectives will certainly result in substantial improvements to the final

document produced, but it will also create obstacles for its development.

Criteria for Inclusion of Material in the HSM

The authors of the chapters of the first edition have a challenge ahead of them. They will need to distill a large amount of published and unpublished literature before deciding what should be incorporated in the first edition of the HSM, particularly in terms of the proposed knowledge part of the HSM. Similar issues relate to the predictive part of the HSM. Unambiguous criteria are needed for the authors to decide when particular knowledge or research findings should be included in the first edition. All authors should receive the same guidelines to decide what quantitative information as well as qualitative information should be included in the first edition.

Although it is left to the HSM JSC and subsequent researchers to develop the criteria, it should be recognized that the criteria will change over time. In fact, the criteria should be able to become more exacting for future editions. Generalized qualitative knowledge on one topic may be adequate for inclusion in the first edition, simply because it represents the best available and verifiable safety effect of a specific factor, a particular geometric design, and/or traffic control practice. However, in later years, predictive models may be developed that use an accident modification function for a specific factor, thereby obviating the need to include generalized information in the knowledge chapters. Or, more recent research may become available that allows more stringent criteria to be applied to determine if the generalized qualitative knowledge is still applicable. In either case, the criteria will change.

Research Protocols/Criteria for Acceptance of Research Findings

This topic generated considerable discussion during the project. Crash predictive models are limited in terms of their accuracy, reliability, and applicability. The debate continues as to whether or not a particular model is adequate for application and whether or not its use should be promoted. It was argued that definitive research protocols need to be established now so that they can be properly followed in future research efforts, thereby ensuring that the findings can be incorporated into future editions of the HSM. The need to establish criteria or procedures for the acceptance of research findings into the predictive models was also identified. For example, how should accident modification functions be updated? What are the conditions that must exist before new research findings should be integrated into or even replace the accident modification functions presented in the first edition? The Research Task Group of the HSM JSC has grappled with this issue and identified some initial actions. Although the general direction has been identified, much work in this area remains.

Quantitative Versus Qualitative Information

One of the ultimate goals of the HSM is to provide users with a set of tools that allows them to assess and estimate the safety effects of a particular action, design, strategy, or treatment for the widest range of highway facility types and functional classes. A set of tools that consider the effects of many factors or variables and predicts the safety effects in terms of estimated crash experience for a wide range of roadway features and situations is desirable. However, current predictive procedures have not been developed to a sufficient level of detail, nor have they been developed for a large number of situations, roadway features, or highway types. Thus, there is great value to providing the most detailed information about safety effects, even if they cannot be readily converted into factors for a predictive methodology. Many of those involved with the HSM JSC and related organizations have embraced the general concept that there should be a knowledge part in the HSM and that it should contain both quantitative and qualitative knowledge. If the best available information about the safety effect of a specific item is only qualitative, then there have been few objections expressed about including the qualitative information in the HSM. There should be no rush to provide quantitative information about safety effects if the basis for those findings is flawed. Similarly, if the quantitative information is based on a very limited sample or if there are some reasonable concerns about the applicability of that information, then it should not be included in the first edition of the HSM. It is recognized that many users will desire more detailed quantitative knowledge and find qualitative information lacking in its ability to meet their needs. Consequently, the goal should be that qualitative information will be replaced with quantitative knowledge in future editions.

Emerging Safety Effects

The need for proper consideration of this issue will be continual. Those involved in road planning, design, operations and maintenance decisions will continue to need knowledge on the safety effects of emerging technologies, practices and systems. For example, traffic engineers may want to know the safety effects of light-emitting diode (LED) signals compared with conventional glass lenses for traffic signal displays. Transportation planners may want to know the safety effects of specific traffic-calming devices. Highway design engineers may want to know the safety effects of innovative intersection designs, roundabouts, and other novel geometric treatments. In many cases, the knowledge of the safety effects will not be readily available. In fact, it may take several years before the empirical evidence is sufficient to

permit inferences about the relative safety effects. The question arises as to what information, if any, should be presented in the Manual until the safety effects are adequately quantified. This becomes even more important if the Manual will be updated frequently or is web-based. The custodians of the HSM will bear the burden for new and improved information on safety effects from the highway safety community. The HSM Task Force discussed the concept of providing a "current topics in safety" service. This service would address emerging safety issues between versions of the HSM. Materials such as research results or topic syntheses would be identified and distributed. Potential methods of distribution identified included a publicly accessible website and printed materials.

Scope of the Document

Although the final report presents recommendations on a draft annotated outline for the first edition of the HSM and several suggested "placeholders" for future sections and subsections in subsequent editions, the scope of the document may need to be re-defined in the future. There are many situations and examples for which information on safety effects are clearly needed. For example, red light running camera systems were raised as an issue in the annotated outline. Are these systems forms of automated enforcement and therefore not appropriate for the defined first edition of the HSM? Or, are they special treatments instituted at problematic intersections as a safety measure? The distinction was not readily apparent to the authors of the report. Consequently, guidance for both alternatives are presented in the draft annotated outline. Several other situations exist where it is not readily apparent whether they should be excluded from, treated casually in, or explicitly discussed in the HSM.

Custodial Role of TRB's HSM Joint Subcommittee

The HSM JSC has initiated and will continue to exercise some degree of stewardship over the HSM. To be a viable document, the consensus was that the HSM should be developed under the sponsorship of TRB, in a manner similar to that of the Highway Capacity Manual. The process has been initiated to transform the structure of the Joint Subcommittee to a full-fledged, standing committee that will have, as one of its primary objectives, the production, oversight, and stewardship of the HSM. The purview of this committee has been discussed. Rather than restricting the JSC to the development and production of the Manual, the committee should have some influence over the research on safety effects, especially those that may be incorporated in future editions of the HSM. How the HSM JSC evolves and the definition of the extent of its purview will have a large bearing on the scope, content, format, and substance of future HSM editions. Thus, the role of the HSM JSC probably will be redefined in the years to come.

Endorsement/Acceptance by the Highway Safety Community

This may be one of the biggest issues that will need to be considered if the HSM is to achieve its intended objective. Acceptance will require substantial effort and investment. The HSM JSC User Liaison Task Group has conducted a comprehensive survey of potential users and endeavored to involve others in the development of the HSM. Several of the comments received from that survey, particularly from those involved in transportation planning, were addressed in the development of the final annotated outline. In fact, the outline was revised to incorporate several additional topics identified by the survey respondents. Acceptance and endorsement by potential users warrants further attention. More detailed research on desired format and applications is needed. To become a nationally accepted and widely used resource, additional outreach and marketing are needed. Relatively minor investments for marketing activities related to the HSM made at the early stages of the development process will yield benefits when the first edition is ready for release.

Audience

Athough this digest recommends that the first edition of the HSM be geared toward transportation professionals (including all those highway geometric design engineers, transportation planners, and traffic engineers, involved in planning, design and operational decisions for roads and highways), many potential future users exist. As development continues, the issue of audience should be periodically resurfaced and discussed. The goal should be to ensure that the HSM is reaching its primary and secondary targeted populations and the format and content of the HSM are meeting the needs of its users. Considerations should be given to exploring methods to enhance and expand on the applicability of the content. Examining the evolution of the Highway Capacity Manual with respect to the changing audience of users may well be helpful. Although capacity was, at first, primarily a traffic operations subject, procedures have been developed and expanded for planning and design. By analogy, the changing needs of the expected users of the HSM need to be assessed and considered in the continuing development of the HSM.

Format for the HSM

The approach taken for this research project was to model the prototype chapter after the current paper-based format used by the Highway Capacity Manual. The draft prototype chapter, which is presented in Appendix C of the final report, presents a methodology that could be applied to predict the safety effectiveness for two-lane, rural highways. The procedures were derived from the latest and best avail-

able methods under development in the United States. This was a conscious decision to use this format and these procedures to serve as an initial trial balloon. The underlying philosophy was that it was important to address the type of content first. Namely, what will the predictive methodology allow a user to do, as opposed to attempting to define the most appropriate format. The prototype chapter as prepared cannot represent the final content for this chapter in the first edition. Relevant research projects underway will influence the version that will be included in the first edition. In addition, the format of the draft prototype chapter may not be the final format. The determination of the most appropriate medium in which to deliver the first edition of the HSM warrants further discussion and development.

There may be a need for differences in format for the chapters to be included in Part II, Knowledge, compared with the format in Part III, Predictive Methods. Part II is intended to present the best available information (i.e., knowledge), on the safety effects of various items, including roadway features and situations, geometric design elements, traffic control devices, traffic operations strategies, pedestrian and bicycle considerations, and so forth. For certain situations, the information may be qualitative and represent the best available knowledge about safety effects. For other items, the information may be quantitative. For a few items, the information may be quite detailed and represent an established relationship between crashes and some specific factor in the form of a crash modification function. The intent of Part II is to cover a broader range of situations and factors than simply those variables that are in the final form of a crash prediction methodology for a specific highway type. In comparison, the material to be contained in Part III, Predictive Methods, should be presented so that would-be users can easily and properly apply the methods to the appropriate situations. For Part III, a format that ensures consistent application of the methods would be more useful. Consequently, the format of Part II could differ from the format of Part III, regardless of delivery media. Function should be considered when selecting format.

Evolutionary Nature of the HSM's Predictive Methods Part

For the Predictive Methods part of the HSM, the methods are likely to improve and to expand so that they can be applied to a greater range of situations found in and on roadways, pedestrian facilities, and bicycle facilities. Thus, the documentation should be presented so that users can fully understand the limitations and applications of the methods. Although the methods presented in the first edition of the HSM should represent the best available, they should not be presented as the definitive procedures.

Relationship of the HSM to Existing Policies

Members of the HSM task groups identified the potential for conflicts between materials in the HSM and existing polices, manuals, and standards. The MUTCD and AASHTO's Green Book were cited as examples. Although there may be conflicts with these and other materials, the task groups recommended that what is appropriate be put forward. It was suggested that the policy task group should define a process to manage conflicts as they arise. This process could include a way to identify where conflicts may arise. Coordination with the groups that publish manuals, standards, and existing policies is crucial.

CONCLUSIONS AND SUGGESTED RESEARCH

The overall conclusion of this effort is that there is a need to conduct the basic research that will be the foundation of the content for the first edition of the Highway Safety Manual. This is especially true for the chapters that constitute Part III of the Manual.

The annotated outline and work plan developed as part of this research and included as Appendix A and B of the final report identify suggested research needed to produce the first edition of the highway safety manual.

Additional research areas have been identified by the task groups of the JSC. Information on these research areas is available from the JSC.

Given that the vision of a Highway Safety Manual is still emerging, the content and format of the Highway Safety Manual will evolve. Some of the major decisions reached by the JSC for the purposes of this study are likely to be modified and changed during this process.

Report Availability

The complete final report for NCHRP Project 17-18(4) is available on TRB's website as *Web Document 62*

Acknowledgments

This study was conducted under NCHRP Project 17-18(4), "Development of a Highway Safety Manual." It was guided by NCHRP Project Panel 17-18, chaired by Mr. Thomas E. Bryer, with members Dr. Leanna DePue, Ms. Adele Derby, Ms. Barbara Harsha, Mr. Bruce Ibarguen, Ms. Margaret Moore, Ms. Kim Nystrom, Mr. Peter F. Rusch, Mr. Rudy Umbs, Mr. Anthony Wyatt, Dr. Ray Krammes, Dr. Jesse Blatt, Mr. Ken Kobetsky, and Dr. Richard Pain.

APPENDIX A

HSM OUTLINE

Part I—Introduction and Fundamentals
Chapter 1. Introduction and Overview
1.1 Purpose
1.2 Background on the Need for HSM
1.3 Scope of the HSM
1.4 Intended Audience
1.5 Intended Use of the HSM
1.6 Context for the HSM: Use and Misuse of the Manual
1.7 Nature of the HSM
1.8 Organization of HSM
Chapter 2. Fundamentals
2.1 What is Safety?
2.2 How Road Safety is Measured
2.3 Safety Performance Functions and Crash Modification Factors
2.4 Human Factors in Road Safety
2.5 Speed and Safety
2.6 Safety Evaluation
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Chapter 3. Roadway Segments
3.1 Safety Effects of Highway Design Elements
3.2 Safety Effects of Traffic Control and Other Operational Elements
3.3 Pedestrians and Bicycle Safety on Roadway Segments
3.4 Safety Effects of Other Elements
Chapter 4. Intersections
4.1 Safety Effects of Intersection Design Elements
4.2 Safety Effects of Intersection Traffic Control and Operation Elements
4.3 Safety Effects of Other Intersection-Related Features
Chapter 5. Interchanges
5.1 Safety Effects of Interchange Design Elements
5.2 Safety Effects of Traffic Control and Operations Elements
5.3 Safety Effects of Interchange Spacing
Chapter 6. Special Facilities and Geometric Situations
6.1 Railroad-Highway Grade Crossings
6.2 Construction and Maintenance Work Zone Areas
6.3 Bridges
6.4 High Occupancy Vehicle (HOV) Lanes/Facilities
6.5 Tunnels
6.6 Reversible Lanes
6.7 Weaving Areas, Collector-Distributor Roads, and Frontage Roads
6.8 Transit Facilities and Related Features
6.9 Bicycle and Pedestrian Facilities and Related Features
Chapter 7. Road Networks
7.1 Introduction
7.2 Safety in Transportation Network Planning
7.3 Safety in the Planning and Design of Residential Neighborhoods and Commercial Areas
7.4 One-Way Systems and Turn Restrictions
7.5 Safety in Traffic Calming
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Part III—Predictive Methods
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8.2 Methodology
8.3 Applications
8.4 Example Problems
8.5 References
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Chapter 9. Rural, Multi-Lane Highways
9.1 Introduction
9.2 Methodology
9.3 Procedures for Application
9.4 Safety Issues Not Explicitly Addressed by the Methodology
9.5 Sample Calculations
9.6 Software for Performing Calculations
9.7 References
Appendices
Chapter 10. Urban and Suburban Arterial Highways
10.1 Introduction
10.2 Methodology
10.3 Procedures for Application
10.4 Safety Issues Not Explicitly Addressed by the Methodology
10.5 Sample Calculations
10.6 Software for Performing Calculations
10.7 References
Appendices
Part IV—Safety Management of a Roadway System
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Background
Chapter 11. Identification of Sites With Promise
Chapter 12. Diagnosis of the Nature of Safety Problems at Specific Sites
Chapter 13. Selection of Countermeasures to Reduce Accident Frequency and Severity at Specific Sites
Chapter 14. Economic Appraisal of All Sites Under Consideration
Chapter 15. Prioritize Rankings of Improvement Projects
Part V—Safety Evaluation (include alternatives)
Chapter 16. Overview of Estimating the Safety Effect of Implemented Interventions
16.1 Introduction
16.2 Why Evaluate?
16.3 Data Needs and Limitations
16.4 Approach to Conducting a Valid Evaluation
Glossary

These digests are issued in order to increase awareness of research results emanating from projects in the Cooperative Research Programs (CRP). Persons wanting to pursue the project subject matter in greater depth should contact the CRP Staff, Transportation Research Board of the National Academies, 500 Fifth Street, NW, Washington, DC 20001.

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